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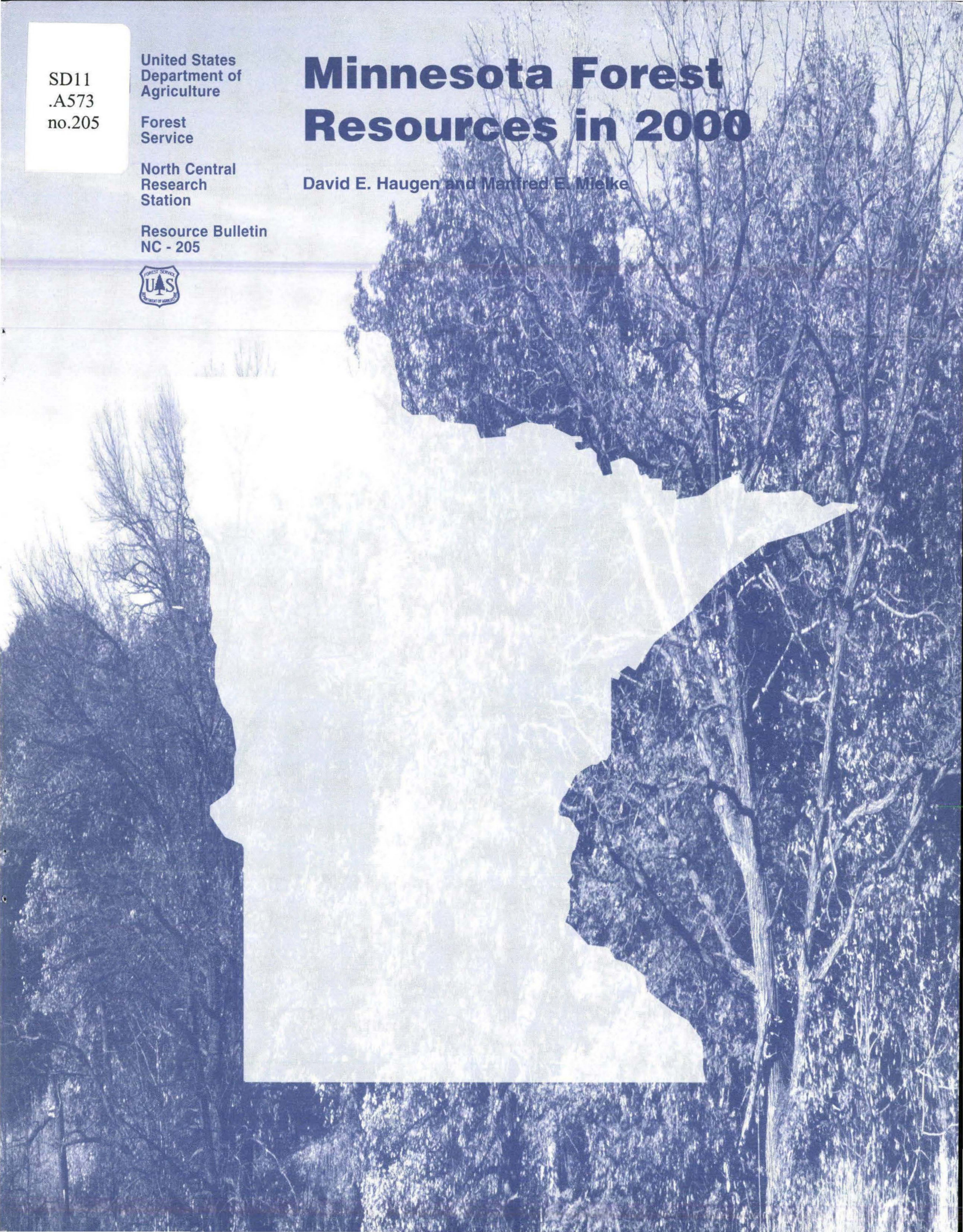
Minnesota Forest Resources in 2000

David E. Haugen and Manfred E. Mielke



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Minnesota Forest Resources in 2000

The North Central Research Station's Forest Inventory and Analysis Program (NCFIA) began fieldwork for the sixth forest inventory of Minnesota's forest resources in 1999. This inventory initiated the new annual inventory system in which one-fifth of the field plots (considered one panel) in the State are measured each year. A complete inventory consists of measuring and compiling the data for all plots (or five panels). Once all panels have been measured, each panel will be remeasured approximately every 5 years. For example, in Minnesota, the plots in the 1999 panel will be remeasured in 2004.

In 2000, NCFIA continued the annual inventory effort with the second panel of the sixth forest inventory. This sixth inventory of Minnesota's forest resources will be completed in 2004. However, because each year's sample is a systematic sample of the State's forest and because timely information is needed about Minnesota's forest resources, estimates have been prepared from data gathered during the first 2 years of the inventory. Data presented in this report represent 40 percent of the field plots (or two panels) for a complete inventory and are a combination of the first year's panel from 1999 and the second year's panel from 2000. **Because of the limited number of field plots measured, sampling errors are large at this point and data in this report should be used with caution. Future estimates that incorporate data in this report are subject to change when ensuing annual inventories are completed and data compiled.** Results presented are estimates based on sampling techniques. As additional annual inventories are completed, the precision of the estimates will increase and additional data will be released.

Reports of previous inventories of Minnesota are dated 1936, 1953, 1962, 1977, and 1990. Data from new inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have occurred since the last Minnesota inventory in 1990 (Miles *et al.* 1995). (See appendix). Some of these changes make it inappropriate to directly compare portions of the 2000 data with those published for 1990.

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RESULTS

Area

The total land area of Minnesota is 50.9 million acres (Miles *et al.* 1995), of which 32 percent or 16.5 million acres are forested. Forest land area remained relatively unchanged between 1990 and 2000, estimated at 16.6 million acres in 1990 and 16.5 million acres in 2000. Analysis of the 1990 periodic inventory measurements and the 1999 – 2000 annual inventory measurements indicates that this slight decrease in estimated total area of forest land may be a result of high sampling errors associated with a partial inventory rather than an actual loss of forest land between the two inventories (Hansen *et al.* 2001). As succeeding annual inventories are completed, sampling errors will decrease, resulting in increased precision of the estimates and a more reliable picture of reality. Timberland, a subset of forest land that is capable of growing trees at a rate of at least 20 cubic feet per acre per year of net growth and that is not restricted from harvesting, showed a slight increase of 3 percent between 1990 and 2000, going from 14.7 million acres in 1990 to 15.1 million acres in 2000 (fig. 1). In 2000, over 91 percent of all forest lands in Minnesota were classified as timberland. The increase in timberland area can be attributed in part to land conversion of pasture and croplands through both natural processes and human intervention (tree planting and wildfire control) and in part to new forest lands that had been partially covered with trees but that did not have sufficient tree cover to qualify as forest land in the previous inventory.

The aspen-birch forest type, with over 6.7 million acres of timberland, is the dominant forest type in the State (fig. 2) and is an important resource for Minnesota's forest industries. The spruce-fir forest type, with over 3.0 million acres of timberland, makes up over three-quarters of all conifer forest land area in the State. Between inventories, hardwood forest types increased from 10.2 million acres in 1990 to just over 11.2 million acres in 2000, while conifer forest types

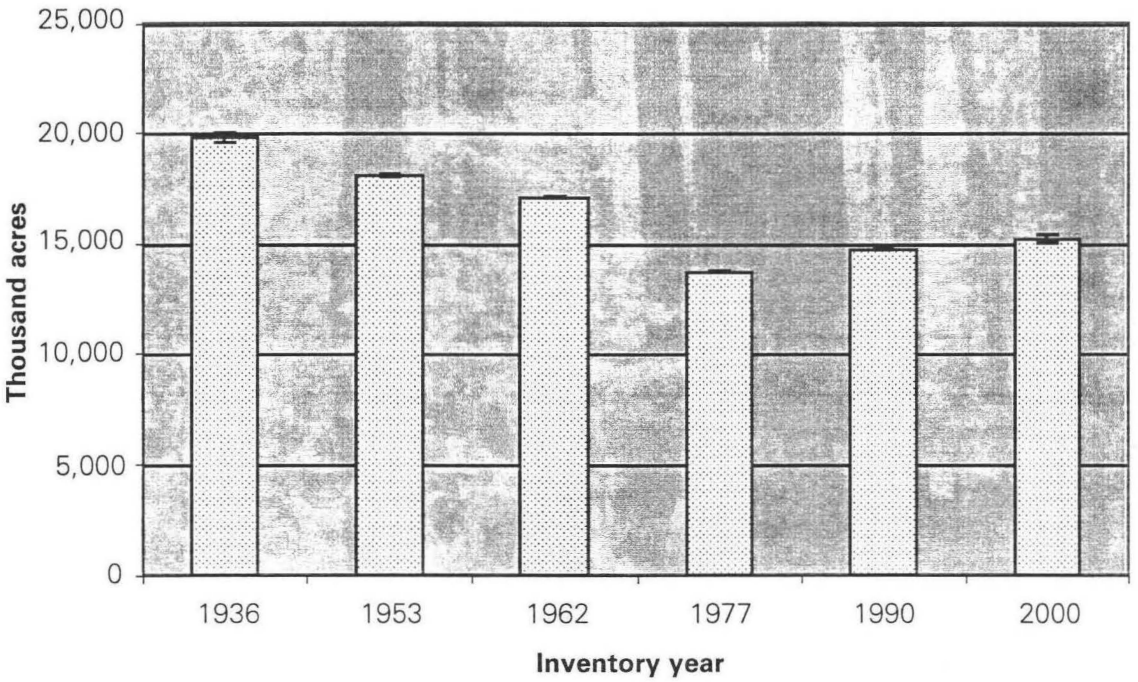


Figure 1. — Area of timberland in Minnesota by inventory year.

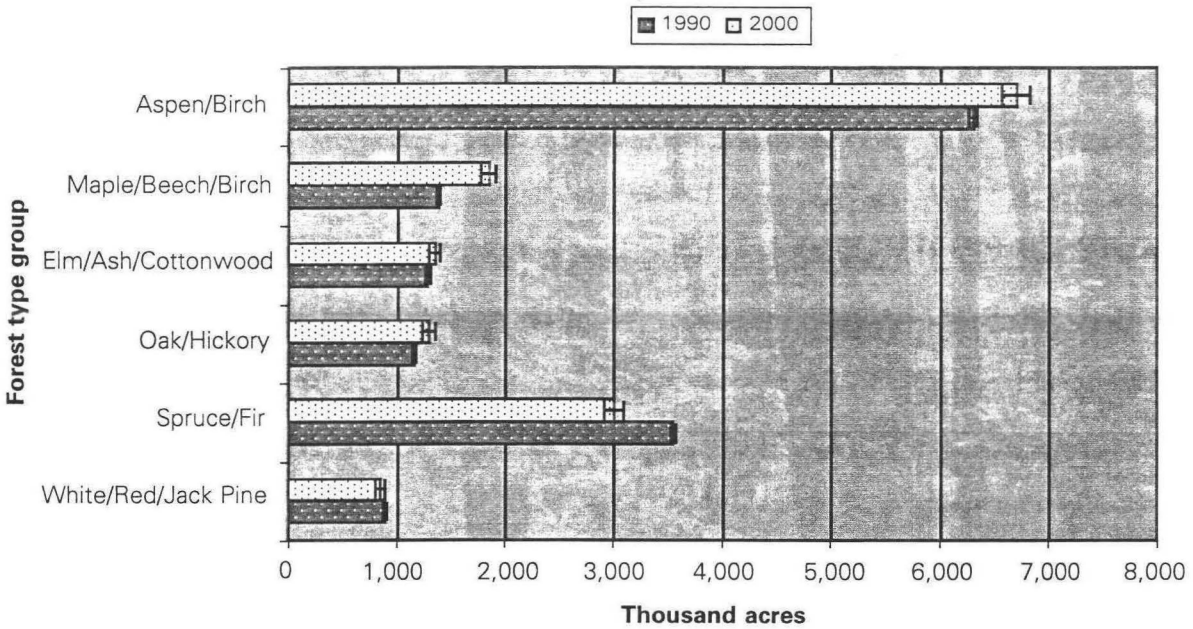


Figure 2. — Area of timberland in Minnesota in 1990 and 2000 by forest type.

decreased from 4.4 million acres in 1990 to 3.8 million acres in 2000. Hardwood forest types, especially aspen, have replaced softwood types on many sites (Leatherberry *et al.* 1995). The area differences between inventory cycles show that forest species composition in Minnesota is changing.

Forest land in public ownership remained relatively unchanged between inventories, at 9.2 million acres in 2000 (fig. 3). More than three-quarters of all conifer forest types are found on publicly owned land. Private forest land ownership between inventories remained constant at 7.2 million acres. Over 85 percent of all private forest land is found in the hardwood forest types.

Timberland area in the smallest average stand-size class (commonly referred to as sapling/seedling-size stands, which have more than half of their total live tree stocking in trees less than 5.0 inches at diameter at breast height—d.b.h.) increased by 20 percent between inventories. This increase represented a gain of about 900 thousand acres by 2000

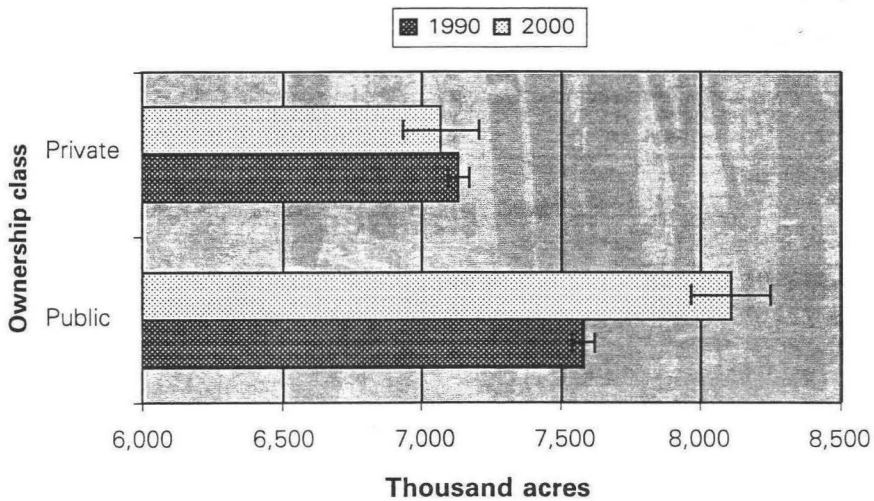


Figure 3. — Area of forest land in Minnesota by owner category.

(fig. 4). Medium stands (commonly referred to as poletimber, stands with half or more of their total live tree stocking in trees at least 5.0 inches in d.b.h.), rose from 5.3 million acres of timberland in 1990 to over 5.5 million acres in 2000. In 2000, large stands (commonly referred to as sawtimber, stands with half or more of their total live tree stocking in trees at least 9.0 inches d.b.h. for conifers or 11.0 inches d.b.h for deciduous trees) actually decreased by more than 700 thousand acres. In 2000, timberland area was comprised of the following stand-size classes: sawtimber 27 percent, poletimber 37 percent, sapling/seedling 35 percent, and nonstocked <1 percent. For more information on how FIA determines stand-size class, see Miles *et al.* (1995).

Volume

Historically, volume has been reported as either growing stock or sawtimber. However, there are volumes in noncommercial trees, rotten trees, and rough trees that do not qualify as growing stock but that are utilized for wood fiber and fuelwood and that make important ecological contributions (such as for wildlife habitat, and soil and water protection). With the annualized inventory system and increased interest in FIA data from an ecological perspective, a greater focus has been placed on all live volume. In 2000, Minnesota had almost 17.6 billion cubic feet of all live volume on its 16.5 million acres of forest land. This equates to an average of more than 1,066 cubic feet of all live volume for each forest land acre in Minnesota. Unfortunately, all live volume is not readily available from the historic inventories and thus comparisons over time consider only growing-stock volume.

The net volume of growing stock on timberland in Minnesota was estimated at 14.8 billion cubic feet in 2000, which equates to

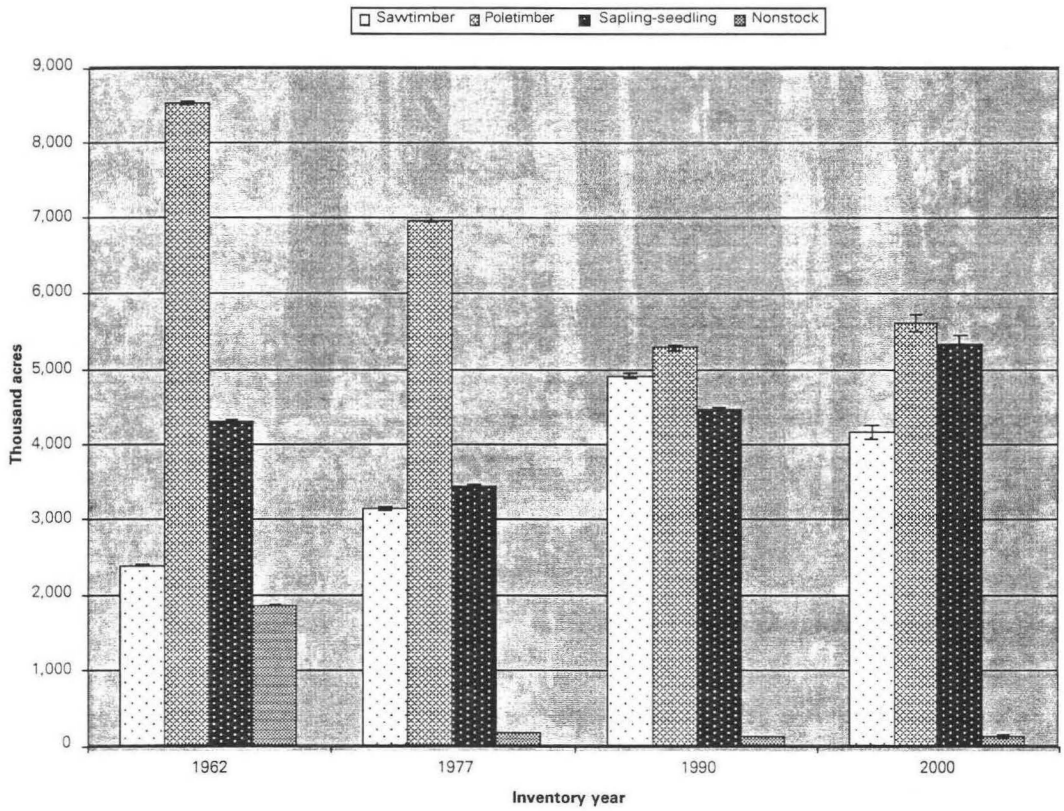


Figure 4. — Area of timberland in Minnesota by stand-size class and inventory year.

977 cubic feet of growing-stock volume per acre (fig. 5). Over 70 percent of Minnesota's growing-stock volume comes from hardwood species and accounts for more than 67 percent of sawtimber volume in the State (fig. 6). In 2000, the cottonwood-aspen species group accounted for over 37 percent of all hardwood growing-stock volume in the State. In contrast, ash, with over 1 billion cubic feet of volume, accounted for 10 percent of hardwood growing-stock volume.

Softwood growing-stock volume was estimated at more than 4.4 billion cubic feet in 2000. The spruce-balsam fir species group, with over 1.6 billion cubic feet of growing-stock volume, was the number one species group in terms of growing-stock volume for conifers. The eastern white and red pine species group accounted for more than 21 percent or 900 million cubic feet of growing-stock volume and more than 30 percent of the conifer sawtimber volume in 2000.

Biomass

Biomass, measured as all live aboveground tree biomass on timberlands in Minnesota, was estimated at more than 429 million dry tons in 2000 (an average of over 28 dry tons per acre). Biomass is an important measure because it provides information that can be used for analyses related to carbon

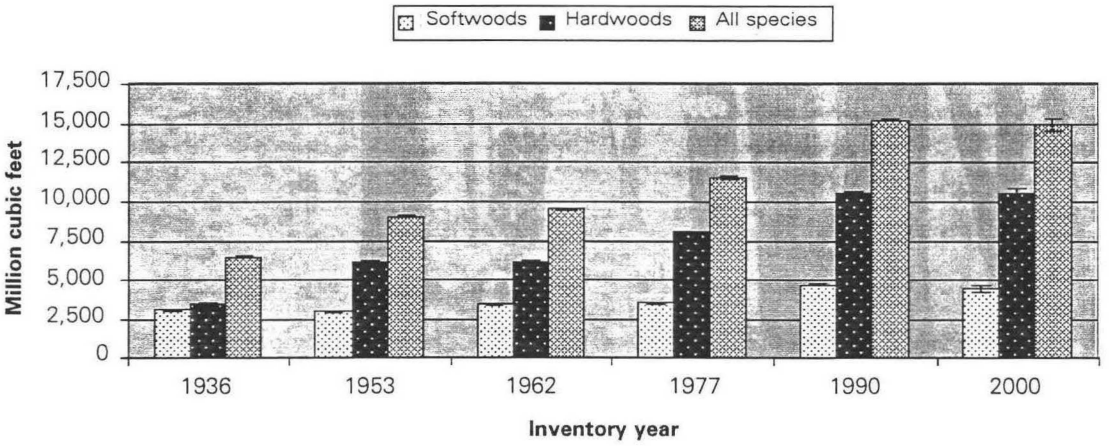


Figure 5. — Growing stock volume in Minnesota by inventory year.

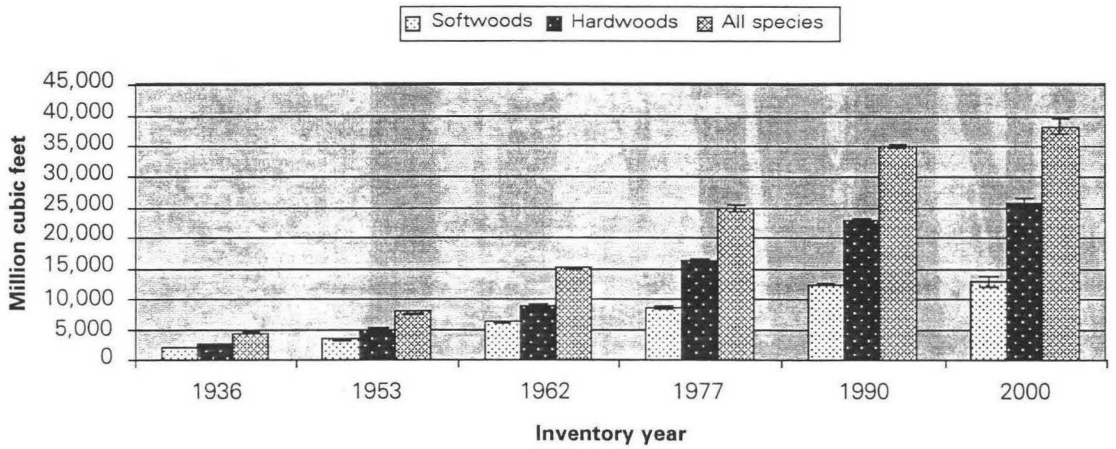


Figure 6. — Sawtimber volume in Minnesota by inventory year.

sequestration, wood fiber availability for fuel, and other issues. In 2000, more than 76 percent of the total biomass was in growing-stock trees, an additional 14 percent was in trees less than 5.0 inches d.b.h., and the remaining 10 percent was in non-growing-stock trees. Over 76 percent of the total biomass was composed of hardwood species. Although total biomass was almost evenly split on private (214 million dry tons) and public (215 million dry tons) timberlands, softwoods made up 34 percent of the total biomass on public lands, but only 13 percent of the total biomass on private lands.

Forest Health

Insects, pathogens, weather, fire, and other factors cause damage and losses on forests throughout Minnesota every year. Since 1954, the eastern spruce budworm (*Choristoneura fumiferana*) has defoliated spruce/fir forests annually, establishing itself as the most consistently damaging agent in the State. However, since 1994, the spruce budworm has been declining steadily (table 10, fig. 7). As the budworm has declined, other damage agents have stepped up their activity. Most notably the forest tent caterpillar (*Malacosoma disstria*) has been active throughout aspen and birch forests, culminating in over 7.7 million acres of defoliation in 2001. Populations are expected to continue to be at damaging levels in 2002. Other significant damage agents that have been active between inventories are the large aspen tortrix (*Choristoneura conflictana*) affecting the aspen and birch forest types; jack pine budworm (*Choristoneura pinus*) defoliating and killing older, open growing jack pine; and the introduced larch casebearer (*Coleophora laricella*), which has been increasing recently in defoliating larch (table 10).

Since 1997, all of these and other defoliating agents have been active, sometimes on some of the same acreages at the same time. Many trees that are repeatedly defoliated sustain measurable growth loss, which in turn, sometimes results in mortality. Figure 7 shows areas of the State where, since 1997, forested lands have been defoliated between one and five times.

Arguably, agents completely beyond human control, namely the weather, cause the most significant damage. Periods of drought and flooding, snow, ice, cold, and wind damage are an integral component of the State's forest dynamics. The single most significant event occurred in 1999 when about 465,000 acres of northern forests were blown down by straight-line winds (fig. 8). This caused varying degrees of breakage and mortality, which in turn has had longer term impacts on subsequent insect and pathogen activity and fire. The annual current mortality resulting from all of these damage agents, exceeding 10 percent of standing trees, is displayed in figure 9. A more complete discussion of forest health issues that have affected Minnesota forests since the last complete forest inventory and of current events is available at *http://www.na.fs.fed.us/spfo/fhm/fhh/fhh-01/mn/mn_01.htm.*

Summary

In summary, Minnesota forest resources appear to be in good health. As additional data become available from ensuing annual inventories, a clearer picture of the direction of Minnesota forests will emerge. Additional data related to the most recent three inventories of Minnesota (1977, 1990, 2000) are available at *www.ncrs.fs.fed.us/4801/fiadb/index.htm.*

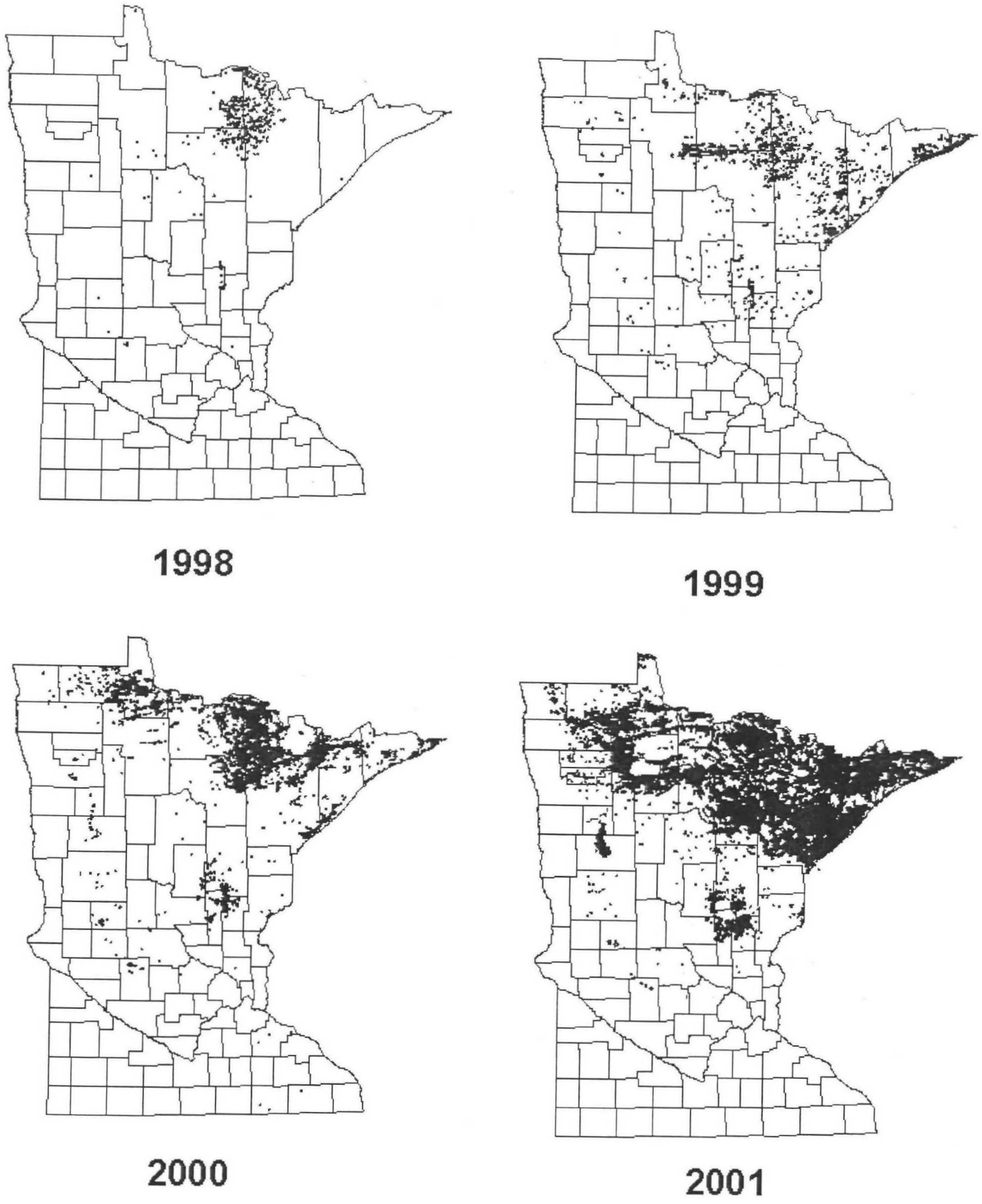


Figure 7. — Minnesota aerial survey results: defoliation 1998–2001.

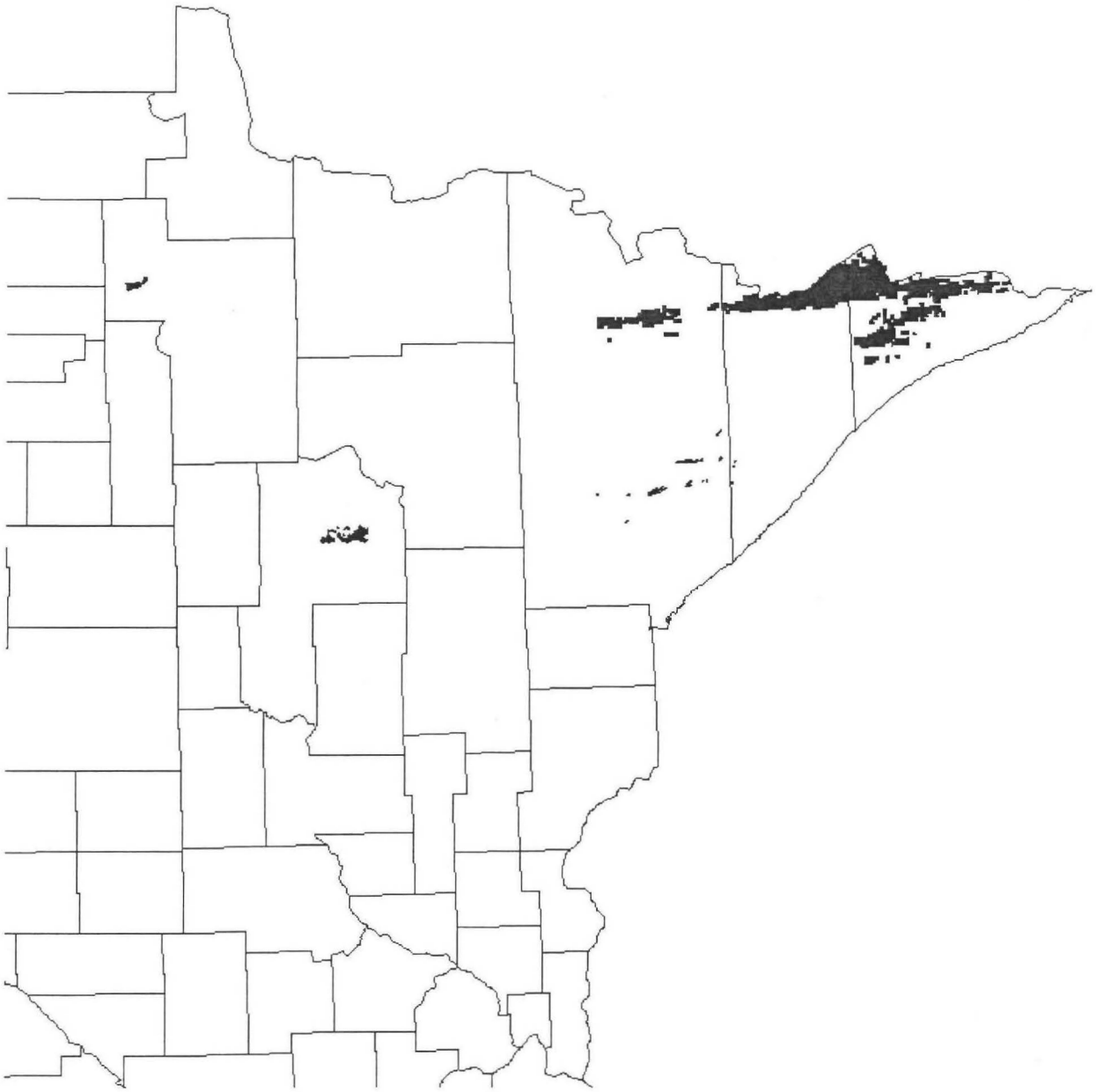
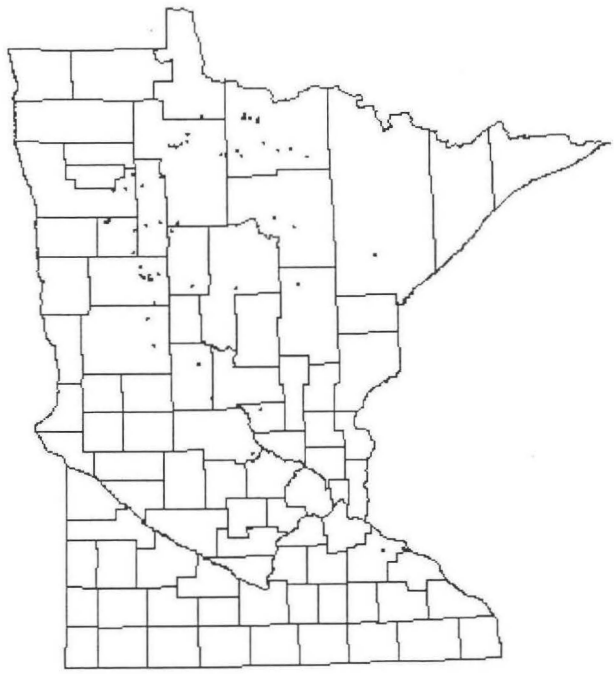


Figure 8. — Minnesota aerial survey results: storm damage 1999.

1998



1999

2000

2001

Figure 9. — Minnesota aerial survey results: mortality 1998–2001.

APPENDIX

Inventory Methods

Minnesota's Forest Resources in 1999 (Schmidt 2001) provides a full description of the NCFIA annualized inventory methods for Minnesota. Since the 1990 inventory of Minnesota, several changes have been made in NCFIA inventory methods to improve the quality of the inventory as well as meet increasing demands for timely forest resource information. The most significant difference between inventories was the change from periodic inventories to annual inventories. Historically, NCFIA periodically inventoried each State on a cycle that averaged about 12 years for recent inventories. However, the need for timely and consistent data across large geographical regions, combined with national legislative mandates, resulted in NCFIA's implementation of an annual inventory system. Minnesota was one of the first States in the North Central region, and one of the first States in the Nation, to be inventoried with this new system, beginning with the 1999 panel of measurements.

With an annual inventory system, about one-fifth of all field plots are measured in any one year. After 5 years, an entire inventory cycle will be completed. After the first 5 years, NCFIA will report and analyze results as a moving 5-year average. For example, NCFIA will be able to generate a report based on inventory results for 1999 through 2004 or for 2000 through 2005. While there are great advantages for an annual inventory, one difficulty is reporting on results in the first 4 years. With the 2000 annual measurements, only 40 percent of all field plots have been measured. Sampling error estimates for the 2000 inventory results are area of forest land 1.13 percent, area of timberland 1.29 percent, number of growing-stock trees on timberland 2.74 percent, volume of growing stock on timberland 2.52 percent, and volume of sawtimber on timberland 3.57 percent. These sampling error estimates are considerably higher than those for the last periodic inventory completed in 1990 (i.e., 0.36 percent for timberland area and 0.71 percent for growing-stock volume) because of the smaller sample sizes. Thus, caution should be used when drawing conclusions based on this limited data set. As we complete ensuing measurements, we will have additional confidence in our results due to the increased number of field plots measured. As each measurement year is completed, the precision of estimates will improve.

Other significant changes between inventories include the implementation of new remote sensing technology, the implementation of a new field plot design, and the gathering of additional remotely sensed and field data. The advent of remote sensing technology since the previous inventory in 1990 has allowed NCFIA to use computer-assisted classifications of Multi-Resolution Land Characterization (MRLC) data and other available remote sensing products to stratify the total area of the State and to improve estimates. Inventories in Minnesota before 1999 used manual interpretation of aerial photos to stratify the sample in 1936, 1953, 1962, 1977, and 1990.

New algorithms were used in 2000 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency among States and will

be used to reassign the forest type and stand-size class of every plot measured in the 1990 inventory when it is updated. This will be done so that changes in forest type and stand-size class will more accurately reflect actual changes in the forest and not changes in how values are computed. The list of recognized forest types, grouping of these forest types for reporting purposes, equations used to assign stocking values to individual trees, definition of nonstocked, and names given to the forest types changed with the new algorithms. As a result, comparisons between the published 1999–2000 measurement results and those published for the 1990 inventory may not be valid. For additional details about algorithms used in both inventories, please contact NCFIA.

Sampling Phases

The 2000 Minnesota survey used a two-phase sample for stratification that included remeasuring inventory plots from the 1990 inventory and measuring new field plots. Two-phase sampling, also called double sampling, consists of a phase-1 sample to estimate area by strata and a phase-2 sample to estimate the average value of parameters of interest within these strata. The estimated population total for a parameter is the sum across all strata of the product of each stratum's estimated area and the parameter's estimated mean per unit area.

The only land that could not be sampled was private land where field personnel could not obtain permission from the owner to measure the field plot and plots that could not be accessed because of a hazard or danger to field personnel. The methods used in the preparation of this report make the necessary adjustments to account for sites where access was denied or hazardous. Fortunately, there were only 22 denied access or hazardous plots in 1999 and 58 denied access or hazardous plots in 2000.

Phase 1

The Minnesota inventory used a computer-assisted classification of satellite imagery. FIA used the imagery to form two initial strata—forest and nonforest. Pixels within 60 m (2 pixel widths) of a forest/nonforest edge formed two additional strata—forest/nonforest and nonforest/forest. Forest pixels within 60 m on the forest side of a forest-nonforest boundary were classified into forest/nonforest strata. Pixels within 60 m of the boundary on the nonforest side were classified into nonforest/forest strata. An overlay of all national forest land was used to identify all lands owned by national forests. These national forest lands were treated separately but were also stratified into one of the above four strata. Stratification and estimation were conducted at the State level for national forest lands and at the FIA Inventory unit level for other lands. In the national forest stratum, forest and forest/nonforest strata were combined.

Phase 2

Phase 2 of the inventory consisted of the measurement of the annual sample of field plots in Minnesota. Current FIA precision standards for annual inventories require a sampling intensity of one plot for approximately every 6,000 acres. FIA has established a grid that divides the entire area of the United States into non-overlapping hexagons, each of which contains approximately 5,937 acres (McRoberts 1999). A grid of field plots was established by selecting one plot from each hexagon based

on the following rules: (1) if a Forest Health Monitoring (FHM) plot (Mangold 1998) fell within a hexagon, it was selected as the grid plot; (2) if no FHM plot fell within a hexagon, the existing NCFIA plot from the 1998 inventory nearest the hexagon center was selected as the grid plot; and (3) if neither FHM nor existing NCFIA plots fell within the hexagon, a new NCFIA plot established at the hexagon center was selected as the grid plot (McRoberts 1999). This grid of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Minnesota is funded by the Federal government.

The total Federal base sample was systematically divided into five interpenetrating, non-overlapping subsamples or panels. Each year the plots in a single panel are measured, and panels are selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots may be considered an independent systematic sample of all land in a State. Field crews measure vegetation on plots forested at the time of the last inventory and on plots currently classified as forest by trained photointerpreters using aerial photos or digital ortho-quads.

NCFIA has two categories of field plot measurements—phase 3 plots (FHM plots) and phase-2 field plots—to optimize our ability to collect data when available for measurement. Both types of plot are systematically distributed both geographically and temporally. Phase-3 plots are measured with the full suite of FHM vegetative and health variables collected as well as the full suite of measures associated with phase-2 plots. Phase-3 plots must be measured between June 1 and August 30 to accommodate the additional measurement of non-woody understory vegetation, ground cover, soils, and other variables. We anticipate that in Minnesota the complete 5-year annual inventory will involve about 390 phase-3 plots. On the remaining plots, referred to as phase-2 plots, only variables that can be measured throughout the entire year are collected. In Minnesota, the complete 5-year annual inventory is expected to involve about 6,530 phase-2 forested plots. The 1999/2000 annual inventory results represent field measures on 1,644 timberland, 102 other forest land, and 323 non-forest land plots. The above number of field plots represents a double intensification of the standard base Federal sample. This intensification was made possible by additional resources provided by the State of Minnesota.

The new national FIA 4-point cluster plot design (fig. 10) was first used for data collection during the 1999 measurement of Minnesota. This design was also used in the 2000 measurement and will be used in subsequent years. The national plot design requires mapping forest conditions on each plot. Due to the small sample size (20 percent) each year, precision associated with change factors such as mortality will be relatively low. Consequently, we will not report change estimates until at least three annual panels have been measured, and even then we anticipate that estimates of change will be limited in detail. When the complete annual inventory has been implemented in 2004, the full range of change variables will be available.

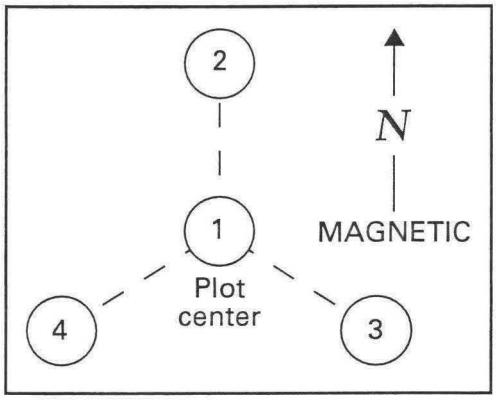


Figure 10. — Current NCFIA field plot design.

The overall plot layout for the new design consists of four subplots. The centers of subplots 2, 3, and 4 are located 120 feet from the center of subplot 1. The azimuths to subplots 2, 3, and 4 are 0, 120, and 240 degrees, respectively. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed within the sample unit. Trees with diameter at breast height (d.b.h., or 4.5 feet above ground level) 5 inches and larger are measured on a 24-foot-radius (1/24 acre) circular subplot. All trees less than 5 inches d.b.h. are measured on a 6.8-foot-radius (1/300 acre) circular microplot located at the center of each of the four subplots. Forest conditions that occur on any of the four subplots are recorded. Factors that differentiate forest conditions are changes in forest type, stand-size class, land use, ownership, and density. Each condition that occurs anywhere on any of the subplots is identified, described, and mapped if the area of the condition meets or exceeds 1 acre in size.

Field plot measurements are combined with phase-1 estimates in the compilation process and table production. The number of tables generated from a single year's data is limited. However, as additional annual inventories are completed, the number of tables will increase until year 5, when all statewide inventory summary tables will be available in both printed and electronic formats. For additional information, contact:

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Table 5.—*Net volume of all live trees and salvable dead trees on timberland by class of timber and softwood/hardwood categories, Minnesota, 1999-2000*

Table 6.—*Net volume of growing stock on timberland by forest group and softwood/hardwood species categories, Minnesota, 1999-2000*

Table 7.—*Net volume of growing stock on timberland by species group and diameter class, Minnesota, 1999-2000*

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Table 9.—*All live aboveground tree biomass on timberland by owner category, softwood/hardwood species category, and tree biomass component, Minnesota, 1999-2000*

Table 10.—*Area of forest land in Minnesota affected by damage agents 1994-2001*

TABLES

Table 1. -- Area of forest land by forest type group and owner category, Minnesota, 1999 - 2000

(In thousand acres)

Forest type group	Owner category			
	All owners	Public	Private	Unidentified owner
Softwood type groups				
White / red / jack pine group	995.7	670.6	325.1	--
Spruce / fir group	3,506.4	2,807.3	699.2	--
Exotic softwood group	6.4	--	6.4	--
All softwood types	4,508.6	3,477.9	1,030.7	--
Hardwood type groups				
Oak / hickory group	1,338.7	350.3	988.4	--
Elm / ash / cottonwood group	1,454.7	557.3	897.4	--
Maple / beech / birch group	1,905.5	689.7	1,215.8	--
Aspen / birch group	7,167.2	4,118.3	3,048.9	--
All hardwood types	11,866.1	5,715.5	6,150.6	--
Nonstocked	147.7	96.8	51.0	--
All forest types	16,522.4	9,290.2	7,232.3	--

Table value of 0.0 indicates the acres round to less than 0.1 thousand acres.

Table 2. -- Area of timberland by major forest type group, stand origin, and owner category, Minnesota, 1999 - 2000

(In thousand acres)

Major forest type group and stand origin	Owner category			
	All owners	Public	Private	Unidentified owner
Softwood type groups				
Natural	3,342.6	2,606.2	736.4	- -
Planted	507.6	306.9	200.7	- -
All softwood types	3,850.2	2,913.2	937.0	- -
Hardwood type groups				
Natural	10,974.4	5,021.0	5,953.4	- -
Planted	230.6	89.8	140.8	- -
All hardwood types	11,204.9	5,110.8	6,094.1	- -
Nonstocked	128.5	85.3	43.3	- -
All groups	15,183.7	8,109.2	7,074.4	- -

Table value of 0.0 indicates the acres round to less than 0.1 thousand acres.

Table 3. -- Area of timberland by forest type group and stand-size class, Minnesota, 1999 - 2000

(In thousand acres)

Forest type group	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-seedling	Non-stocked
Softwood type groups					
White / red / jack pine group	841.0	329.4	353.5	158.0	--
Spruce / fir group	3,002.7	405.7	900.0	1,697.0	--
Exotic softwood group	6.4	4.0	--	2.4	--
All softwood types	3,850.2	739.1	1,253.6	1,857.5	--
Hardwood type groups					
Oak / hickory group	1,301.5	763.6	400.7	137.2	--
Elm / ash / cottonwood group	1,353.0	361.1	596.1	395.8	--
Maple / beech / birch group	1,850.1	944.0	687.7	218.4	--
Aspen / birch group	6,700.4	1,342.9	2,655.5	2,702.0	--
All hardwood types	11,204.9	3,411.6	4,340.0	3,453.4	--
Nonstocked	128.5	--	--	--	128.5
All forest types	15,183.7	4,150.7	5,593.5	5,310.9	128.5

Table value of 0.0 indicates the acres round to less than 0.1 thousand acres.

Table 4. -- Net volume of all live trees on forest land by species group and owner category, Minnesota, 1999 - 2000

(In thousand cubic feet)

Species group	Owner category			
	All owners	Public	Private	Unidentified owner
Softwoods				
Other yellow pines	9,011	--	9,011	--
Eastern white and red pines	1,148,813	793,189	355,625	--
Jack pine	555,148	374,386	180,763	--
Spruce and balsam fir	1,890,358	1,399,841	490,517	--
Other eastern softwoods	1,536,168	1,187,355	348,813	--
Total softwoods	5,139,498	3,754,770	1,384,728	--
Hardwoods				
Select white oaks	952,897	180,628	772,268	--
Select red oaks	863,951	272,397	591,554	--
Other red oaks	100,686	5,474	95,212	--
Hickory	31,067	--	31,067	--
Yellow birch	52,197	42,900	9,297	--
Hard maple	684,962	381,634	303,328	--
Soft maple	828,549	416,725	411,824	--
Beech	--	--	--	--
Ash	1,174,385	434,783	739,603	--
Cottonwood and aspen	4,705,286	2,702,251	2,003,035	--
Basswood	1,052,706	328,888	723,818	--
Black walnut	16,314	--	16,314	--
Other eastern soft hardwoods	1,971,355	1,060,301	911,054	--
Other eastern hard hardwoods	3,222	--	3,222	--
Eastern noncommercial hardwoods	35,503	9,703	25,800	--
Total hardwoods	12,473,081	5,835,685	6,637,396	--
All species groups	17,612,579	9,590,456	8,022,123	--

Table value of 0 indicates that the volume round to less than 1 thousand cubic feet.

Table 5. -- Net volume of all live trees and salvable dead trees on timberland by class of timber and softwood/hardwood categories, Minnesota, 1999 - 2000

(In thousand cubic feet)

Class of timber	All species	Softwood species	Hardwood species
Live trees			
Growing-stock trees			
Sawtimber			
Saw log portion	8,191,855	2,144,012	4,047,843
Upper stem portion	1,796,360	301,541	1,494,819
Total	7,988,215	2,445,553	5,542,663
Poletimber	6,892,174	1,957,991	4,934,183
All growing-stock trees	14,880,389	4,403,543	10,476,846
Cull trees			
Rough trees [1]			
Sawtimber size	821,670	59,653	762,016
Poletimber size	289,254	33,759	255,495
Total	1,110,924	93,412	1,017,512
Rotten trees [1]			
Sawtimber size	184,196	23,940	160,256
Poletimber size	36,072	5,315	30,757
Total	220,268	29,254	191,013
All live cull trees	1,331,191	122,666	1,208,525
All live trees	16,211,580	4,526,210	11,685,371
Salvable dead trees			
Sawtimber size	203,864	67,466	136,398
Poletimber size	165,398	64,840	100,558
All salvable dead trees	369,262	132,306	236,956
All classes	16,580,842	4,658,516	11,922,326

Table value of 0 indicates that the volume round to less than 1 thousand cubic feet.
[1] Includes noncommercial species.

Table 6. -- Net volume of growing stock on timberland by forest group and softwood/hardwood species categories, Minnesota, 1999 - 2000

(In thousand cubic feet)

Forest type group	All species	Softwood species	Hardwood species
Softwood type groups			
White / red / jack pine group	1,135,508	1,032,354	103,154
Spruce / fir group	2,179,184	1,969,825	209,359
Exotic softwood group	6,896	6,707	189
All softwood types	3,321,588	3,008,886	312,702
Hardwood type groups			
Oak / hickory group	1,558,074	39,804	1,518,270
Elm / ash / cottonwood group	1,450,410	168,462	1,281,949
Maple / beech / birch group	2,472,389	151,547	2,320,842
Aspen / birch group	6,068,813	1,027,814	5,040,999
All hardwood types	11,549,686	1,387,626	10,162,059
Nonstocked	9,115	7,031	2,084
All forest types	14,880,389	4,403,543	10,476,846

Table value of 0 indicates that the volume round to less than 1 thousand cubic feet.

Table 7. -- Net volume of growing stock on timberland by species group and diameter class, Minnesota, 1999 - 2000

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height)									
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Other yellow pines	7,065	358	1,614	2,795	2,298	--	--	--	--	--	--
Eastern white and red pines	943,469	91,607	136,140	140,161	81,547	78,419	92,274	99,260	96,807	107,211	20,043
Jack pine	438,967	55,806	98,188	124,714	87,565	37,927	14,010	16,691	4,065	--	--
Spruce and balsam fir	1,656,975	527,905	487,863	331,751	160,129	66,764	41,835	22,306	11,344	7,078	--
Other eastern softwoods	1,357,067	256,908	301,602	294,223	199,613	138,998	63,315	45,096	14,807	42,505	--
Total softwoods	4,403,543	932,583	1,025,407	893,645	531,153	322,108	211,434	183,354	127,022	156,794	20,043
Hardwoods											
Select white oaks	776,872	55,998	82,531	106,659	96,719	76,879	91,130	70,754	29,751	131,406	35,046
Select red oaks	779,169	20,511	59,845	100,659	135,200	129,635	93,605	67,293	99,841	63,849	8,731
Other red oaks	62,733	1,958	5,349	4,535	6,488	4,027	4,857	13,486	2,754	19,280	--
Hickory	30,635	3,193	4,426	7,048	8,205	4,236	3,527	--	--	--	--
Yellow birch	37,972	3,417	4,290	4,140	2,986	3,714	3,270	8,486	--	7,670	--
Hard maple	532,871	82,691	111,848	102,123	75,076	45,526	41,499	30,427	9,835	33,847	--
Soft maple	623,083	102,747	128,905	95,297	73,851	44,943	29,609	11,767	13,012	89,247	33,704
Beech	--	--	--	--	--	--	--	--	--	--	--
Ash	1,069,186	169,915	245,628	219,217	134,157	108,793	68,335	43,089	26,809	44,191	9,053
Cottonwood and aspen	3,979,212	448,395	622,256	726,460	693,383	604,359	427,296	192,192	91,779	125,767	47,324
Basswood	941,480	85,554	115,244	149,588	120,740	137,474	116,863	63,127	82,442	58,251	34,197
Black walnut	15,724	285	806	3,204	3,833	1,292	6,303	--	--	--	--
Other eastern soft hardwoods	1,624,815	264,791	430,927	380,651	265,991	142,969	98,949	12,424	8,853	19,260	--
Other eastern hard hardwoods	3,094	1,379	1,072	643	--	--	--	--	--	--	--
Total hardwoods	10,476,846	1,220,833	1,813,127	1,900,224	1,616,630	1,303,846	985,242	513,045	365,075	590,768	168,056
All species	14,880,389	2,153,416	2,838,534	2,793,868	2,147,782	1,625,956	1,196,676	696,399	492,098	747,562	188,099

Table value of 0 indicates that the volume round to less than 1 thousand cubic feet

Table 8. -- Net volume of sawtimber on timberland by species group and diameter class, Minnesota, 1999 - 2000

(In thousand board feet)[1]

Species group	All classes	Diameter class (inches at breast height)							
		9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Other yellow pines	24,621	13,385	11,236	--	--	--	--	--	--
Eastern white and red pines	3,825,144	697,525	408,550	405,609	487,164	543,884	544,597	617,700	120,115
Jack pine	1,407,875	593,991	430,144	194,120	74,664	91,718	23,239	--	--
Spruce and balsam fir	3,302,995	1,662,214	821,380	354,243	229,478	127,111	65,510	43,058	--
Other eastern softwoods	4,153,397	1,484,803	1,024,036	728,086	340,541	247,496	83,530	244,905	--
Total softwoods	12,714,032	4,451,919	2,695,346	1,682,057	1,131,847	1,010,208	716,875	905,664	120,115
Hardwoods									
Select white oaks	2,477,582	--	397,265	336,828	417,960	333,849	144,055	662,610	185,016
Select red oaks	2,733,104	--	554,933	570,194	429,773	318,857	487,814	325,039	46,495
Other red oaks	242,849	--	27,184	17,943	22,116	64,741	13,728	97,137	--
Hickory	63,736	--	31,226	17,174	15,336	--	--	--	--
Yellow birch	130,163	--	13,570	17,259	15,910	42,884	--	40,540	--
Hard maple	1,084,892	--	313,818	204,632	196,134	147,796	48,997	173,515	--
Soft maple	1,392,811	--	303,177	198,003	135,737	56,492	63,923	452,411	183,068
Ash	2,022,407	--	578,069	501,537	325,035	209,844	132,426	226,737	48,760
Cottonwood and aspen	10,015,877	--	2,955,707	2,747,452	2,026,351	935,890	455,345	636,281	258,852
Basswood	2,886,525	--	514,815	625,584	553,911	308,108	409,954	290,131	184,022
Black walnut	53,496	--	16,806	6,214	30,477	--	--	--	--
Other eastern soft hardwoods	2,358,665	--	1,085,686	627,817	449,662	57,235	42,211	96,054	--
Other eastern hard hardwoods	--	--	--	--	--	--	--	--	--
Total hardwoods	25,462,108	--	6,792,255	5,870,636	4,618,402	2,475,696	1,798,452	3,000,455	906,212
All species	38,176,140	4,451,919	9,487,601	7,552,694	5,750,249	3,485,904	2,515,328	3,906,119	1,026,327

Table value of 0 indicates that the volume round to less than 1 thousand board feet.

[1]International 1/4-inch rule.

Table 9 – All live aboveground tree biomass on timberland by owner category, softwood/hardwood species category, and tree biomass component, Minnesota, 1999 - 2000

(In dry tons)

Owner category and softwood/hardwood category	All components	Tree biomass component						
		All live 1-5 inch trees	Growing-stock trees			Non-growing-stock trees		
			Total	Boles	Stumps, tops, and limbs	Total	Boles	Stumps, tops, and limbs
Public								
Softwoods	71,862,342	14,992,748	54,796,628	41,730,743	13,065,885	2,072,966	1,568,251	504,715
Hardwoods	142,498,133	18,848,290	108,948,542	79,153,816	29,794,726	14,701,301	10,977,661	3,723,640
Total	214,360,474	33,841,038	163,745,170	120,884,558	42,860,611	16,774,267	12,545,912	4,228,355
Private								
Softwoods	27,954,555	3,869,783	23,143,532	17,979,499	5,164,034	941,239	720,245	220,994
Hardwoods	187,643,428	21,498,137	141,494,680	102,664,406	38,830,274	24,650,611	18,244,802	6,405,808
Total	215,597,982	25,367,920	164,638,212	120,643,905	43,994,307	25,591,850	18,965,048	6,626,803
All ownerships								
Softwoods	99,816,896	18,862,531	77,940,160	59,710,242	18,229,918	3,014,205	2,288,497	725,709
Hardwoods	330,141,560	40,346,427	250,443,222	181,818,222	68,625,000	39,351,912	29,222,463	10,129,448
Total	429,958,457	59,208,958	328,383,382	241,528,464	86,854,918	42,366,117	31,510,960	10,855,157

Table value of 0 indicates the aboveground tree biomass round to less than 1 dry ton.

Table 10.--Area of forest land in Minnesota affected by damage agents, 1994-2001[1]

Minnesota damage agents	2001	2000	1999	1998	1997	1996	1995	1994
				(*in acres*)				
Forest tent caterpillar	7,759,807	2,039,919	495,000	9,000	2,064	--	9,120	--
Large aspen tortrix	--	63,942	340,000	9,000	--	--	--	--
Flooding	17,909	30,697	--	--	--	--	--	--
Spruce budworm	18,893	28,481	70,000	240,242	257,000	207,727	500,100	2,704,000
Oak tatters	2,300	20,000	--	--	--	--	--	--
Frost	--	7,507	--	--	--	--	--	--
Larch casebearer	18,816	6,363	--	--	--	--	--	--
Oak mortality	16,800	6,061	--	--	--	--	--	--
Dutch elm disease	1,052	365	--	--	--	--	--	--
Bark beetles	2,122	100	--	--	--	--	--	--
Winter injury	2,424	--	--	--	--	--	--	--
Wind/Tornado	--	--	465,000	--	--	--	217,800	--
Walking stick	--	--	920	--	--	--	--	--
Oak anthracnose	--	--	150,000	--	--	--	--	--
Aspen defoliator complex	--	--	--	--	--	--	36,600	599,627
Jack pine budworm	--	--	--	--	--	74,836	66,501	6,900
Mortality	47,358	20,571	7,614	5,776	10,308	--	--	--
Total acres effected	7,887,481	2,224,006	1,528,534	264,018	269,372	282,563	830,121	3,310,527

All table cells without observations in the inventory sample are indicated by --.

[1]Aerial survey results, 1994-2001.

Haugen, David E.; Mielke, Manfred E.
2002. **Minnesota forest resources in 2000**. Resour. Bull. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 26 p.

Results of the 2000 annual inventory of Minnesota show over 16.5 million acres of forest land, over 17.6 billion cubic feet of all live volume on forest land, and an estimated 429 million dry tons of all live aboveground tree biomass on timberland. Known pests in Minnesota forests include the forest tent caterpillar, spruce budworm, jack pine budworm, large aspen tortrix, and introduced larch casebearer.

KEY WORDS: Annual inventory, forest area, forest type, volume, biomass, Minnesota

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